

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Samuel P. Sawan

Application No.: 09/617,566

Art Unit: 1616

Filed: July 17, 2000

Examiner: N. S. Levy

For: CONTACT-KILLING ANTIMICROBIAL  
DEVICES

**Declaration of Dr. Samuel P. Sawan under 37 C.F.R. § 1.132**

Mail Stop AF  
Commissioner for Patents  
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Dear Sir:

I, SAMUEL P. SAWAN, do hereby declare and state the following:

1. I, Samuel P. Sawan, am a citizen of the United States, and I am more than twenty-one years of age.
2. I make this declaration in support of the above-identified application, U.S. Serial No. 09/617,566 ("the '566 application").
3. I am a named inventor of the '566 application.
4. I presently hold the position of President at Surfacine Development Company LLC.
5. My qualifications as a scientist, and in particular in the field of polymer chemistry, are set forth on the copy of my curriculum vitae, which is attached as Exhibit A. I have worked with using biocidal silver for over 20years.
6. I have read and am familiar with the specification of the '566 application as filed, the Office Action mailed March 8, 2007, British Patent GB 2254340 by Sano ("Sano").

7. Sano describes a polymer resin that has been coated (either through a chemical etch or soldering) with a thick metal coating having electrical conductivity. In claim 19, Sano teaches fixing the polymer resin membrane to retaining plates by soldering the metallic layer to the retaining plates; the bond between the polymer and the metallic layer allows the polymer to be affixed via the metal layer.

8. Many metal surfaces including silver may become oxidized upon exposure to air . Upon oxidation, the surface of silver metal is converted into silver (I) oxide. Silver (I) oxide, although not water soluble itself, readily reacts with water to form silver (I) hydroxide which is water soluble. Although silver is oxidized to a small extent, this is sufficient to provide silver ion levels that are antimicrobial to a wide variety of organisms since silver (I) is biocidal to a wide range of organisms at levels above approximately 0.5 PPM. Thus the spontaneous oxidation of silver metal will provide biocidal levels of silver ion in contacting solutions with silver metal plated surfaces.

9. Based on my substantial experience, a film as described by Sano WILL necessarily release biocidal amounts of elutables if placed in a liquid. Sano teaches a thick uniform metal film (i.e., thick enough to be electrically conductive) useful as a contact for soldering a resin to an object and of a thickness which strengthens the membrane. This film is formed by electroplating silver. However, regardless of how it is formed, a thick silver film will oxidize. Sano did not reduce or remove the propensity of a silver surface to oxidation when he soldered the silver onto an article of manufacture. Therefore, if placed in a liquid, Sano's metal-coated resin membrane will release biocidal amounts of elutables into the surrounding ambient liquid.

10. In contrast, the antimicrobial metallic material as claimed in the '566 application will not oxidize and release metal ions. The silver salt is bound to the polymer matrix wherein the metal is complexed with the polymer matrix (see page 21, last paragraph) as opposed to forming a thick film on top of the polymer matrix. The complex will not oxidize and release biocidal amounts of a metal ion into the ambient liquid. This is demonstrated in the '566 application at Example 6 (page 37 – 38) where silver elution was less than 10 ppb for the adherent antimicrobial coatings described in my invention.

11. I further declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true. I further declare that these statements are made with the knowledge that the willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States code, and that such willful false statements may jeopardize the validity of the instant application or of any patent issued thereupon.

Respectfully submitted,

Dr. Samuel P. Sawan

Date 5-8-07

## **EXHIBIT A**

## Samuel P. Sawan, Ph.D.

### Curriculum Vita

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Department of Chemistry  
University of Massachusetts, Lowell  
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#### **Academic Experience**

- 6/85-present: Professor of Chemistry, Polymer Science/Plastics Engineering Program,  
University of Massachusetts, Lowell
- 9/86-7/89: Chairman, Department of Chemistry, University of Massachusetts, Lowell
- 6/83-6/85: Associate Professor, University of Massachusetts, Lowell
- 9/78-6/83: Assistant Professor, University of Massachusetts, Lowell

#### **Research Areas (comprehensive)**

1. Polysilane chemistry and photochemistry: development of novel polysilane polymers, photodegradative characteristics of silane polymers, nuclear magnetic characterization of polymer microstructure.
2. Biocompatibility of polymers: plasma polymerization - mechanism and characterization of plasma reactions, derivatization of polymer surfaces, coatings of naturally occurring and modified naturally occurring biopolymers.
3. Controlled release drug delivery: hydrolytically unstable polyesters for controlled degradation and release of pharmacologically active compounds.
4. Hydrogels: novel hydrogel compositions, UV curable hydrogels, binding of low molecular weight compounds to gels, thermoplastic hydrogel compositions.
5. Epoxy chemistry and rheology: rheological behavior of filled polymeric solutions, photochemistry in oxirane polymerizations, catalysts and accelerators for the curing of epoxies, formulations for increased performance in electronic devices.
6. Solution behavior of biopolymer analogues: lower consolute solution behavior of biopolymer models, e.g. poly(acrylamides) studied by nuclear magnetic resonance, solution viscosity and light scattering techniques.
7. Urethane chemistry and photochemistry: model urethane systems, thermal and photooxidative evaluation of aryl and alkyl polymers, stabilization of urethanes.
8. Environmentally responsive chemistry and process technologies based upon supercritical fluids.

#### **Academic Activities**

1. Currently directing the activities of a research group of 7 graduate students and postdoctoral associates
2. Previous Head, Department of Chemistry, 1986-89
3. Previous Lecturer on Radiology, Harvard Medical School (1980-1983).
4. Previous Director, Nuclear Magnetic Resonance Facility

#### **Professional Societies**

1. American Chemical Society
2. American Chemical Society, Polymer Chemistry Division
3. American Association for the Advancement of Science
4. Sigma Xi
5. International Union of Pure and Applied Chemistry
6. Society of Plastics Engineers
7. ARVO, Association for Research in Vision and Ophthalmology

#### **Industrial Experience - Consultant**

1. Andover Medical, Inc.
2. International Business Machines
3. Dynatech Corporation
4. CTI-Cryogenics
5. AVCO Corporation
6. Compo Industries
7. Davol, Inc.
8. Millipore Corporation
9. Polytechnics, Inc.
10. Digital Equipment Corporation
11. International Minerals Corporation
12. Optical Radiation Corporation
13. Medtronics, Inc.
14. Bose Corporation
15. Medi-tech, Inc.
16. MIT-Lincoln Laboratories
17. Metaphase Corporation
18. Integrated Design, Inc.
19. Advanced Cardiovascular Systems, Inc.
20. Biometric Systems, Inc.
21. Biomat S.N.C.
22. Mitek Surgical Products
23. IDEXX Laboratories
24. Cambridge Heart, Inc.
25. Synteni
26. Incyte Pharmaceuticals

#### **Education**

- 6/76-8/78      Postdoctoral Scholar  
 Department of Pharmaceutical Chemistry  
 University of California, San Francisco  
 San Francisco, California
- Nuclear Magnetic Resonance Investigations of Enzyme Active Site Residues and Geometry  
 Advisor: Dr. Thomas L. James
- 9/72-12/76      Ph.D., Polymer Science  
 Department of Polymer Science  
 University of Akron  
 Akron, Ohio
- Ph.D. thesis: Nuclear Magnetic Resonance Studies of Synthetic Polypeptide Structures  
 Thesis advisor: Dr. H. James Harwood



9/68-6/72      B.S., Chemistry  
 Department of Chemistry  
 University of Akron  
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### Publications

1. S.P. Sawan and H.J. Harwood, Amer. Chem. Soc., Polymer Div., Polymer Preprints, 17(2), 554 (1976). "Characterization of Stereosequence Distributions at Chain Ends of Synthetic Polypeptides by 300 MHz PMR Spectroscopy".
2. S.P. Sawan and T.L. James, J. Magn. Reson., 32, 173 (1978). "Use of a Plastic Tube Insert for NMR Experiments Entailing Hazardous Samples".
3. S.P. Sawan, T.L. James, L.D. Greunke and J.C. Craig, J. Magn. Reson., 35, 409 (1979). "Proton NMR Assignments for Cholesterol. Use of Deuterium NMR as an Assignment Aid".
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9. A. Taylor, S.P. Sawan and T.L. James, J. Biol. Chem., 257, 11571 (1982). "Structural Aspects of the Inhibitor Complex Formed by N-(Leucyl)-o-aminobenzene Sulfonate and Manganese of Zn+2 Mn+2 Leucine Aminopeptidase".
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13. J.C. Salamone, C.C. Tsai, Q. Anwaruddin, A.P. Olson, M. Arnold, T. Nagabhushanam, S.P. Sawan and A.C. Watterson, J. Polym. Sci., Polym. Chem. Ed., 22, 2005 (1984). "Solution Behavior of Ampholytic Styrene Ionomers".
14. K.P. Muni and S.P. Sawan, Amer. Chem. Soc., Polymer Div., Polymer Preprints, 27(1), 284 (1986). "Rheological Properties of Silica Filled Phenoxy Solutions".
15. N.B. Upadhyay and S.P. Sawan, Amer. Chem. Soc., Polymer Div., Polymer Preprints, 27(1), 253 (1986). "Aqueous Solution Properties of Poly(N-Ethyl Methacrylamide)".
16. S.P. Sawan, K.P. Muni and S.M. Svelnis, Amer. Chem. Soc., Polymer Div., Polymer Preprints, 27(2), 278 (1986). "Viscometric Properties of Phenoxy Solutions Containing Hydrophilic or Hydrophobic Fumed Silica".
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98. S.P. Sawan, S. Subramanyam and A. Yurkovetskiy, Disinfectant Composition Providing Sustained Residual Biocidal Action", US Patent 6,180,584 [2001].
99. S.P. Sawan, S. Subramanyam and Y. Yurkovetskiy, "Contact-Killing Non-leaching Antimicrobial Materials", US Patent 6,264,936 [2001].
100. P.H. Lee, S.P. Sawan, Z. Modrusan, L.J. Arnold and M.A. Reynolds, "An Efficient Binding Chemistry for Glass Polynucleotide Microarrays", Bioconjugate Chemistry 13(1), 97-103 [2002].
101. L.J. Arnold, S.P. Sawan, P.H. Lee, "Polymer Coated Surfaces for Microarray Applications", US Patent 6,387,631 [2002].
102. L.J. Arnold, S.P. Sawan, P.H. Lee, "Polymer Coated Surfaces for Microarray Applications", US Patent 6,413,722 [2002].
103. M.J. Brady, C.M. Lisyay, A.V. Yurkovetskiy and S.P. Sawan, "A Persistent Silver Disinfectant for the Environmental Control of Pathogenic Bacteria", Am J Infection Control 31(4), 208-214 (2003).
104. S.P. Sawan and M.J. Brady, "Persistent Silver Disinfection for the Environment: Myth and Reality: Response", Am. J. Infection Control 32(5), 309-311 (2004).

#### **Presentations**

1. "Carbon Magnetic Resonance of N-Carboxyl Anhydrides and Oligomers Derived from Them", First Annual Federation of Analytical Chemistry and Spectroscopy Societies Meeting, Indianapolis, Indiana, October, 1975.
2. "Evaluation of Chain End Configurations in Synthetic Polypeptides by 300 MHz PMR Spectroscopy", American Chemical Society Midwest Regional Meeting, Akron, Ohio, May, 1976.

3. "Characterization of Stereosequence Distributions at Chain Ends of Synthetic Polypeptides by 300 MHz PMR Spectroscopy", American Chemical Society National Meeting, San Francisco, California, August, 1976.
4. "Cadmium-113 Nuclear Magnetic Resonance Studies of Cadmium (II) Complexes of Amino Acids and Peptides", American Chemical Society Western Regional Meeting, Anaheim, California, October, 1977.
5. "Stereoselection in the Polymerization of Valine N-Carboxyanhydride", NATO Advanced Study Institute on Stereoregular Polymers, Tirenia, Italy, October, 1978.
6. "Stepwise Denaturation of Ribonuclease by Guanidinium Hydrochloride Studied by NMR Rotating Frame Spin-Lattice Relaxation in the Presence of an Off-Resonance Radiofrequency Field", American Chemical Society National Meeting, Honolulu, Hawaii, April, 1979.
7. "Detection of Polymeric Initiator Fragments in Synthetic Polypeptides Prepared by Strong Base Initiated N-Carboxyl Anhydride Polymerizations" American Chemical Society National Meeting, Washington, D.C., September, 1979.
8. "Chelate Resins Specific for Germanium: The Development of an Ionic Ge-68--> Ga-68 Generator for Nuclear Medicinal Applications", American Chemical Society National Meeting, Las Vegas, Nevada, September, 1980.
9. "Controlled Release of Bioactive Agents", invited speaker at International Minerals Corporation, Terre Haute, Indiana, March, 1981.
10. "Studies of Enzyme Active Site Residues and Structures", Invited speaker at Dynatech Corporation, Cambridge, Massachusetts, February, 1983.
11. "Matrix Supported Polymerization of L-Phenylalanine Using Triphenyl Phosphite", American Chemical Society Meeting, Seattle, Washington, March, 1983.
12. "UV Modifiable Epoxy Resins", invited speaker at International Business Machines, Austin, Texas, February, 1984.
13. "Ultraviolet Absorbers for Intraocular Lenses", American Intraocular Implant Society Meeting, American International IOL Congress, Boston, Massachusetts, April, 1985.
14. "Rheological Properties of Silica Filled Phenoxy Solutions", American Chemical Society Meeting, New York, New York, April, 1986.
15. "Aqueous Solution Properties of Poly(N-Ethyl Methacrylamide)", American Chemical Society Meeting, New York, New York, April, 1986.
16. "Viscometric Properties of Phenoxy Solutions Containing Hydrophilic or Hydrophobic Fumed Silica", American Chemical Society Meeting, Anaheim, California, September, 1986.
17. "Viscometric Properties of Phenoxy Solutions Containing Hydrophilic or Hydrophobic Fumed Silica", S.P. Sawan, K. M. Muni and S.M. Svelniss, American Chemical Society Meeting, New York, New York, April, 1986.
18. "Characterization of Copolydiorganosilanes with Varying Compositions", S.P. Sawan, Y.G. Tsai, H.Y. Huang, American Chemical Society Meeting, Denver, Colorado, April, 1987.
19. "Plasma Polymerization of Organosiloxanes", S.P. Sawan and S. Srinivasan, American Chemical Society Meeting, Denver, Colorado, April, 1987.
20. "Plasma Polymerization for Biocompatible Surfaces", S.P. Sawan, invited speaker, Medtronics, Inc., Minneapolis, Minnesota, June, 1987.
21. "Photooxidation of Methylene Bisiscocyanate Based Urethanes", S. P. Sawan, K. Muni and S. Kitchloo, invited paper, Minnowbrook Microelectronics Workshop, Blue Mountain Lake, New York, September 1987.
22. "Biopolymer Coatings for Medical Device Applications", invited speaker, Medi-Tech, Inc., Watertown, Massachusetts, October 1987.
23. "Physical Properties of Photoactive Polysilane Copolymers", S.P. Sawan, Y.G. Tsai and H.Y. Huang, Advances in Silicon-Based Polymer Science, Makaha, Oahu, Hawaii, November 1987.
24. "Polysilanes as Positive Self Developing Photoresists", C. Conley, S.P. Sawan, Y.G. Tsai, and H.Y. Huang, Polymer Science and Plastics Technology Symposium, Sturbridge, MA, March 3, 1988.
25. "Synthesis and Characterization of Copolysilanes", S.P. Sawan, Y.G. Tsai, H.Y. Huang and C. Conley, poster session, Polymer Science and Plastics Technology Symposium, Sturbridge, MA, March 3, 1988.

26. "Rheological Properties of Epoxy Solder Mask Coatings for Electronic Applications", S.P. Sawan and K.P. Muni, poster session, Polymer Science and Plastics Technology Symposium, Sturbridge, MA, March 3, 1988.
27. "Photooxidation of Polyurethane Conformal Coatings", S.P. Sawan, K.P. Muni, S. Kitchloo and P. Schuessler, Society of Plastics Engineers, 46th Annual Technical Conference, Atlanta, GA, April 18-21, 1988.
28. "Polysilanes as Novel Self-Developing Photoresists", S.P. Sawan, Y.G. Tsai, H.Y. Huang and C.C. Conley, presentation, National Organization for the Professional Development of Black Chemists and Chemical Engineers (NOBCChE), Philadelphia, PA, April 6, 1988.
29. "Quantitation of Poly(d,L-Lactic Acid) Degradation Products by HPLC", poster presentation, S.P. Sawan and J.J. Barry, American Chemical Society meeting, Toronto, Canada, June, 1988.
30. "Light Scattering Studies of Polysilane Copolymers", poster presentation, S. P. Sawan, Y.G. Tsai and H.Y. Huang, American Chemical Society meeting, Toronto, Canada, June, 1988.
31. "Thermal Characterization of Polysilane Copolymers", poster presentation, S.P. Sawan, Y.G. Tsai, H.Y. Huang and T.M. Hsu, American Chemical Society meeting, Toronto, Canada, June, 1988.
32. "Polysilanes, Silicon Backboned Polymers: New Ideas, Applications and Theoretical Interests", S.P. Sawan, invited speaker, Medtronics, Inc., September 19, 1988.
33. "Polysilanes, Silicon Backboned Polymers: New Ideas, Applications and Theoretical Interests", S.P. Sawan, invited speaker, American Chemical Society, Minnesota Section, September 20, 1988.
34. "Controlled Release Drug Matrices Composed of Poly(d,L-Lactic Acid) Blended with Ethylene/Vinyl Acetate Copolymer", S.P. Sawan and H.M. Dollinger, USA-Italy Joint Workshop on Polymers for Applications, Capri, Italy, June 11-16, 1989.
35. "Self Developing Photolithography Using Polysilanes with SubMicron Applicability", S.P. Sawan, invited speaker, Digital Equipment Corporation, Andover and Hudson facilities, June 13, 1989.
36. "Biocompatible Surfaces: Design, Characterization and Applications", Technomic Publishing Co., Boston, MA, May 20 - 22, 1991.
37. "Biocompatible Surfaces: Design, Characterization and Applications", Technomic Publishing Co., Basel, Switzerland, October 28 - 30, 1991.
38. "The Use of Supercritical Fluids as Substitutes for Cleaning Solvents", invited speaker, New England Environmental Expo '92, April 30, 1992.
39. "The Use of Supercritical Fluids as Substitutes for Cleaning Solvents", invited speaker, Pollution Prevention Conference and Exposition, Warwick, RI, September 30 - October 1, 1992.
40. "Polysilanes as Photoresist Materials", invited speaker, Texas Instruments technology seminar, March, 1992.
41. "Research on the Effects of Supercritical Carbon Dioxide on Polymers", J.M. Moses and S.P. Sawan, 15th Digital Cleanroom-Cleaning Technology Conference, Chicago, IL, November 10, 1992.
42. "Supercritical Carbon Dioxide Interactions with Polymers", S.P. Sawan, Los Alamos Technical Conference, Los Alamos, NM, 1994.
43. "Polysilanes as Photoresists", S.P. Sawan, University of Dayton invited seminar presentation, October, 1994.
44. "Supercritical Fluids in Polymer Science ", S.P. Sawan, invited speaker, ISCO Corporation, St. Paul, MN, January 31, 1995.
45. "Supercritical Fluids for Precision Cleaning Applications", S.P. Sawan, invited speaker, Toxics Use Reduction Planner Continuing Education Conference, February 28, 1995.
46. "Supercritical Fluids in Polymer Science ", S.P. Sawan, invited speaker, Polaroid Corporation, May 11, 1995.
47. "Interaction of Supercritical Fluids with Crystalline and Amorphous Polymers", S.P. Sawan, IVth Pacific Polymer Conference, American Chemical Society, Polymer Biennial Symposium, December 12-16, 1995.

48. "Critical Review on Photoresists" S.P. Sawan and S.A. Ekhotorumwen, The International Society for Optical Engineering (SPIE) meeting, Denver, CO, August 5-6, 1996.
49. "An Intelligent Antimicrobial Coating for Medical Devices and Health Care", S. Subramanyam, A. Yurkovetskiy and S. P. Sawan, Surfaces in Biomaterials, September 5-7, 1996.
50. S.A. Ekhotorumwen and S.P. Sawan, Synthesis, functional modification and characterization of polysilane copolymers for enhanced photosensitivity and photobleaching", SPIE [International Society for Optical Engineering], January 24-30, 1998.
51. EKHOTORUMWEN, S. A., SAWAN, S. P., "Synthesis, functional modification and characterization of polysilane copolymers for enhanced photosensitivity and photobleaching", Proc. SPIE-The International Society for Optical Engineering, Vol. 3282, 59-67, 1998.

#### **Grants and Contracts**

1. Principal Investigator, American Chemical Society Grant, Sequence Distribution and Solution Properties of Synthetic Polypeptides, September 1979 through August 1980.
2. NATO Conference Attendee, Advanced Study Institute on Advances in the Preparation and Properties of Stereoregular Polymers, October 1978.
3. Co-Principal Investigator, Xerox Corporation Grant, Technical Support and Materials Evaluation Assistance, March 1981 through March 1982.
4. Principal Investigator, United Charitable Trust Award, New Agents for the Diagnosis of Neoplastic Disease, March 1981 through March 1982.
5. Principal Investigator, International Business Machines Grant, Epoxy Resin Investigations, January 1982 through February 1983.
6. Principal Investigator, Compo Industries Grant, Poly(vinyl chloride) Plasticsols, June 1982 through September 1983.
7. Principal Investigator, Dynatech Corporation with Dr. Horne, Controlled Release of Bactericidal and Spermicidal Agents in Vivo, June 1983 through June 1985.
8. Co-Principal Investigator, Ophthalmological Foundation of America, Inc., Contact Angle Measurement and Surface Wetting Improvements in Intraocular Lenses, October 1982 through June 1984.
9. Principal Investigator, International Business Machines Grant, Rheological Properties and Formulations of Epoxy Resins, January 1983 through January 1984.
10. Co-Principal Investigator, Surgidev Corporation Contract, Evaluation of Plastics Used in Intraocular Lenses, April 1983 through January 1984.
11. Principal Investigator, Kontron Corporation, Evaluation of Urethane Elastomers for Catheters, January 1984 through June 1984.
12. Principal Investigator, Gillette Corporation Contract, Characterization of High Impact Polystyrene, March 1984 through July 1984.
13. Principal Investigator, Andover Medical Inc. Grant, Development of Novel Hydrogels, October 1983 through October 1984.
14. Principal Investigator, International Business Machines grant, NMR Studies on Polyimides, July 1984 through June 1985.
15. Principal Investigator, International Business Machines Grant, Chemical and Rheological Developments in Epoxy Coatings, March 1984 through April 1985.
16. Principal Investigator, Upaco Adhesives, Investigations on Urethane Prepolymers, August 1983 through February 1986.
17. Co-Principal Investigator, Ophthalmological Foundation of America, Inc., Investigations on Derivatives of Pilocarpine and Isopilocarpine, July 1984 through June 1986.
18. Principal Investigator, Optical Radiation Corporation, Ultraviolet Light Absorption in Poly(Methyl Methacrylate) Polymers, October 1984 through October 1985.
19. Principal Investigator, International Business Machines grant, Novel Ultraviolet Induced Oxirane Polymerizations, May 1985 through September 1986.
20. Principal Investigator, Digital Equipment Corporation, Polysilane Photopolymers, January 1986 through September 1986.
21. Principal Investigator, Digital Equipment Corporation, Molecular Modeling of Polysilane Polymers, September 1986 through August 1987.

22. Principal Investigator, Digital Equipment Corporation, Preparation of Polysilane Photopolymers, September 1986 through August 1987.
23. Principal Investigator, International Business Machines, Polyurethane Chemistry in Printed Circuit Board Manufacturing, October 1986 through September 1987.
24. Principal Investigator, Medtronics, Inc., Plasma Polymerization for Biocompatible Surfaces, September 87 through May 1988.
25. Principal Investigator, Andover Medical, Inc., Residual Monomer Determination in Hydrogel Compositions, June 1987 through December 1987.
26. Principal Investigator, Massachusetts Centers of Excellence Corp. (MCEC), Molecular Modeling of Polysilane Photo-polymers, June 1987 through May 1991.
27. Principal Investigator, Digital Equipment Corporation, Novel Polysilane Photopolymers, June 1987 through May 1991.
28. Principal Investigator, International Business Machines, Adverse Properties in Process Polymers, January 1988 through December 1988.
29. Principal Investigator, Medtronic, Inc. Photochromic Polymers for Fiber Optic Sensors, June 1988 through May 89.
30. Principal Investigator, International Business Machines, Adverse Process Chemistry Related to Flux - Electronic Materials Interactions", January 89 through December 89.
31. Principal Investigator, Bose Corporation, High Modulus and Low Density Polymeric Structures for High Technology Applications, June 89 through May 91.
32. Principal Investigator, Medtronic, Inc., Bakken Research Center, Surface Modification for Increased Biocompatibility, May 89 through June 90.
33. Principal Investigator, Population Council and CADCO, Inc., Biodegradable Polymers for Controlled Release, July 89 through June 90.
34. Principal Investigator, Advanced Cardiovascular Systems, Inc., Evaluation of Medical Grade Polyurethane, January 90 through August 90.
35. Principal Investigator, Medtronic, Inc., Plasma Modification of Vascular Graft Surfaces for Increased Cellular Adhesion and Growth, February 1990 through January 1991.
36. Principal Investigator, Polymer Technology Corp., Evaluation of Monomers for Contact Lens Applications, June 1990 through November 1990.
37. Principal Investigator, International Business Machines, Adverse Process Chemistry Related to Solvent - Electronic Materials Interactions", January 1990 through June 1991.
38. Principal Investigator, Medtronic, Inc., "Surface Modifications for Increased Cellular Adhesion and Growth", February 1991 through March 1992.
39. Principal Investigator, Metaphase Corp., "UV Polymerizable Monomer Formulations", June 1991 through October 1993.
40. Principal Investigator, Digital Equipment Corporation, "Hydopolysilanes Photopolymer for Electroless Metal Resists", July 1991 through May 1992.
41. Principal Investigator, Presstek, Inc., "Evaluation of Electro Optical Properties of Polysilanes", February 1992 through January 1993.
42. Principal Investigator, International Business Machines, "Supercritical Fluid Interactions with Polymers", March 1992 through June 1993.
43. Principal Investigator, Toxics Use Reduction Institute, "Supercritical Fluid Interactions with Polymers", February 1992 through December 1992.
44. Principal Investigator, Biomat, S.N.C., "Plasma Treatment of Polymers for Increased Protein Adhesion", June 1992 through February 1993.
45. Principal Investigator, Los Alamos National Laboratory, "Interactions of Supercritical Fluids with Polymeric Materials", June 1993 through September 1993.
46. Principal Investigator, Los Alamos National Laboratory, "Material Interactions with Supercritical Fluids", October 1993, through September 1994.
47. Principal Investigator, BioPolymerix, "Evaluation of Novel Biomaterials", September 1994 through September 1996.
48. Principal Investigator, Los Alamos National Laboratory, "Novel Technologies Based Upon Supercritical Fluid Processes", October 1994 through September 1995.

49. Principal Investigator, Massachusetts Department of Environmental Protection, "Use of Supercritical Carbon Dioxide for Cleaning Contaminated Plastic Wastes", November 1994 through June 1995.
50. Principal Investigator, Los Alamos National Laboratory, "Novel Technologies Based Upon Supercritical Fluid Processing of Materials", October 1995 through September 1996.
51. Principal Investigator, Los Alamos National Laboratory, "Polymer Filtration Technology", October 1995 through September 1996.
52. Principal Investigator, Isotag, Inc., "Polymeric Materials for Tagants", January 1996 December 1996.
53. Principal Investigator, Millipore Corp., "NMR Analysis of Membrane Materials", October 1995 through September 1996.
54. Principal Investigator, Los Alamos National Laboratory, "Metal Complexation by Polymers", May 1996 through September 1996.
55. Principal investigator, Cambridge Heart, "Hydrogels for Biomedical Applications", October 1996 through December 1997.
56. Principal Investigator, Synteni, "Novel Chemistries for DNA Binding", November 1996 through December 1997.
57. Principle Investigator, Department of Energy, "Metal Chelation Polymers", February 1997 through January 2000.